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FNSNF

Integrated MEMS actuation for force spectroscopy in liquid

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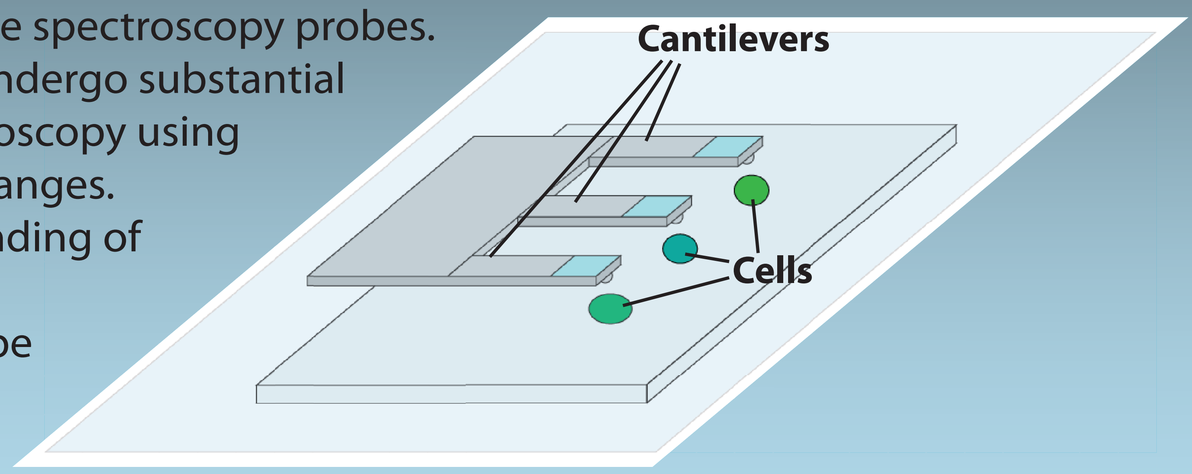
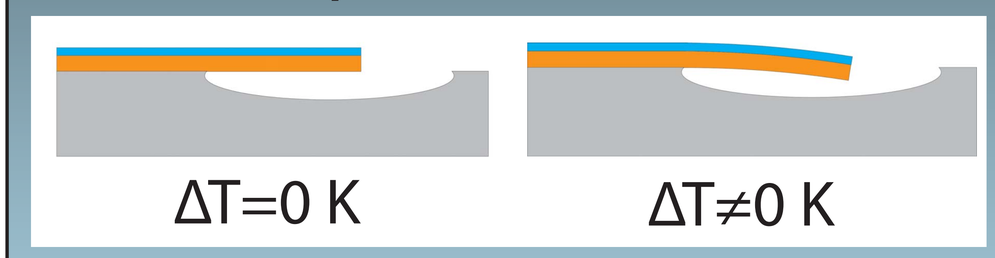
Introduction and purpose

This work aims to develop arrays of individually actuated cell force spectroscopy probes. Cross et al. (Nat. Nanotech. 2007) have shown that human cells undergo substantial mechanical changes as they become cancerous. Cell force spectroscopy using AFM has emerged as a promising candidate to measure those changes.
It is believed that this method will lead to an increased understanding of the disease and potentially also to new diagnosis technologies.
In order to collect a sufficient amount of data, several cells must be measured. In the current state of the technology, iterations are very time-consuming.



The PATLiSci project aims to parallelize these measurements by developing arrays of probes. Our task is to develop such arrays with the additional feature of individual actuation, allowing tuning of the applied force exerted by each probe.

Thermal bimorph effect

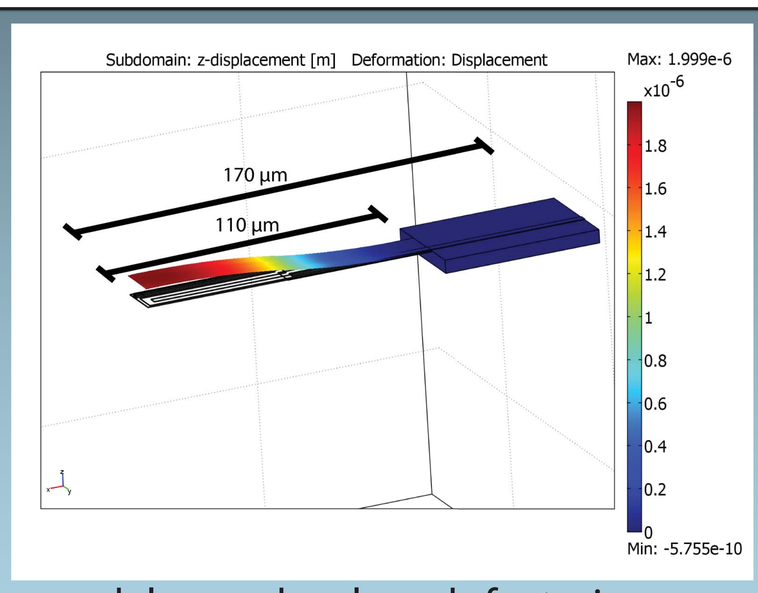


A free-standing bimorph cantilever bends as temperature changes due to differences in expansion coefficient.

Advantages

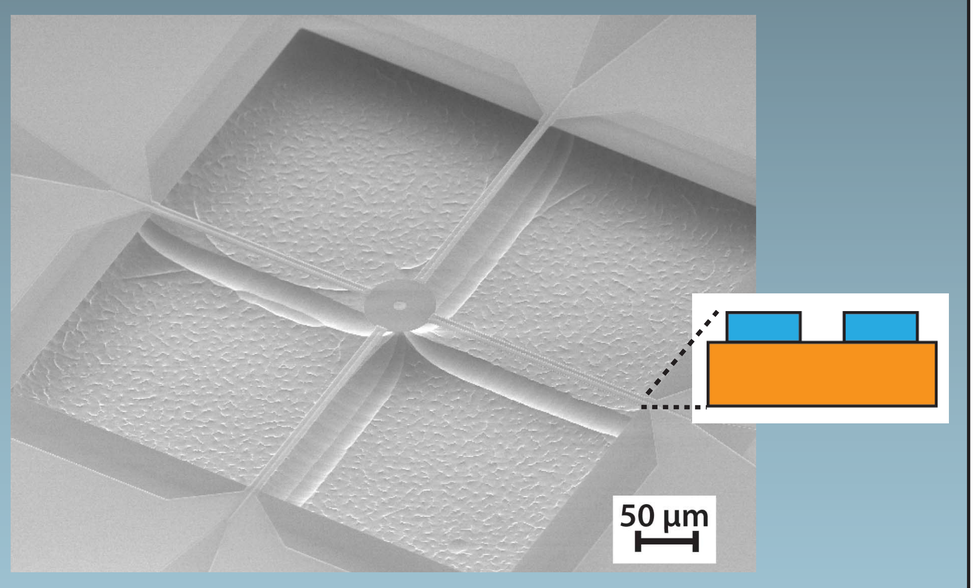
- **Large deformations**
- **Short relaxation time constant in water**
- **Easy to implement**
- **Small scale renders low power consumption**

Simulations

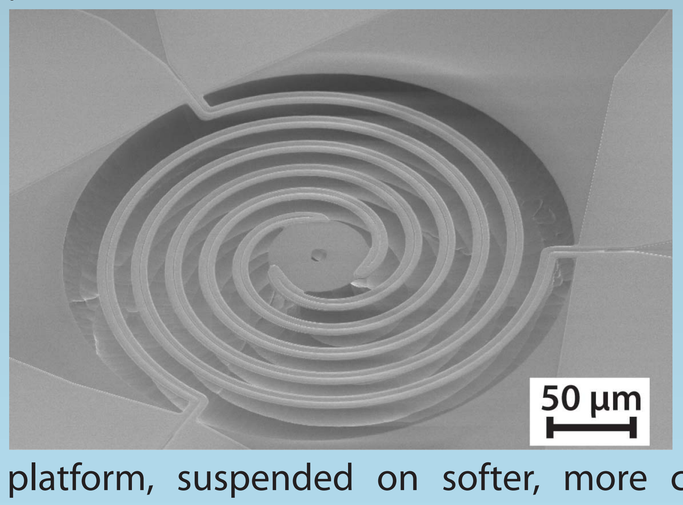


A COMSOL Multiphysics model was developed, featuring a cantilever with heater windings patterened on it. By simulating the structure, we have learned its deformation as well as its temperature and the temperature of the surrounding media (water) at a given current density. At a tolerable current density, the cantilever above bended 2 µm out-of-plane.

Fabrication of test structures

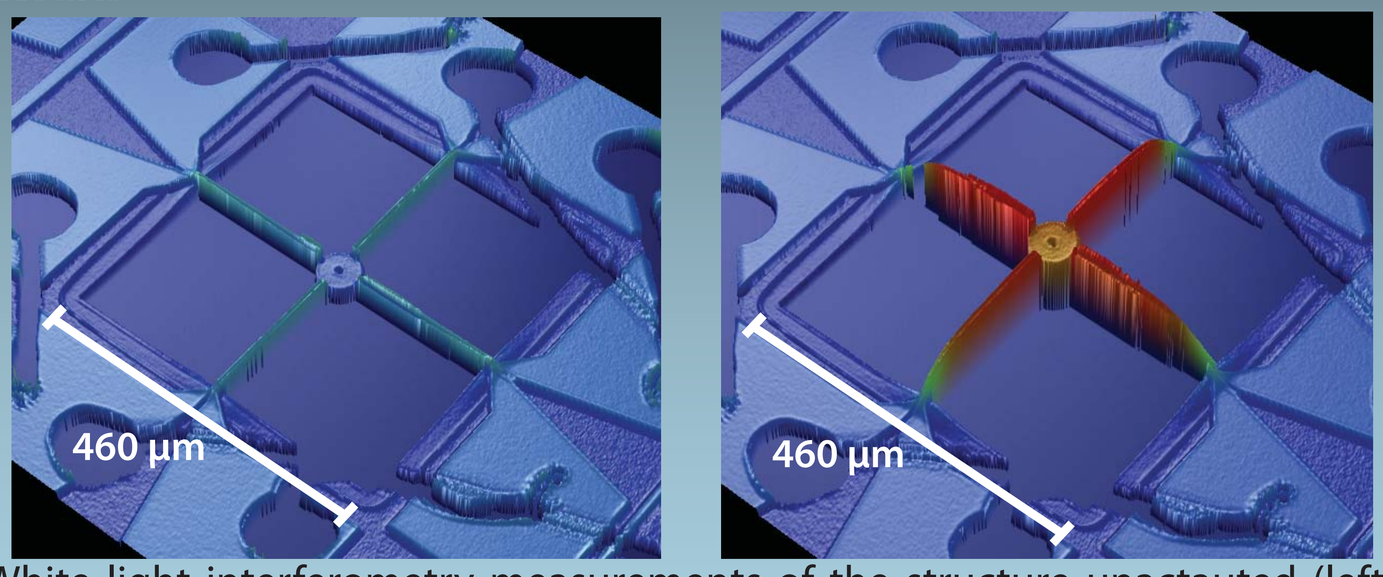


Free-standing platform structure suspended on four springs with actuation electrodes (spring cross-section on the right).



Similar platform, suspended on softer, more compact springs.

Results



White light interferometry measurements of the structure unactauted (left) and actuated (right). The displacement is about 3.5 µm out-of-plane.

Outlook

- **Displacement is already in the desired range. A probe is being designed based on these results, featuring decoupled actuation and sensing.**
- **The trade-off between displacement and temperature will be studied in detail.**
- **High frequency scanning will be investigated.**

References

Cross S E, Jin Y-S, Rao J, Gimzewski J K (2007), *Nanomechanical analysis of cells from cancer patients*. Nat. Nanotechnol. 2 780-3.